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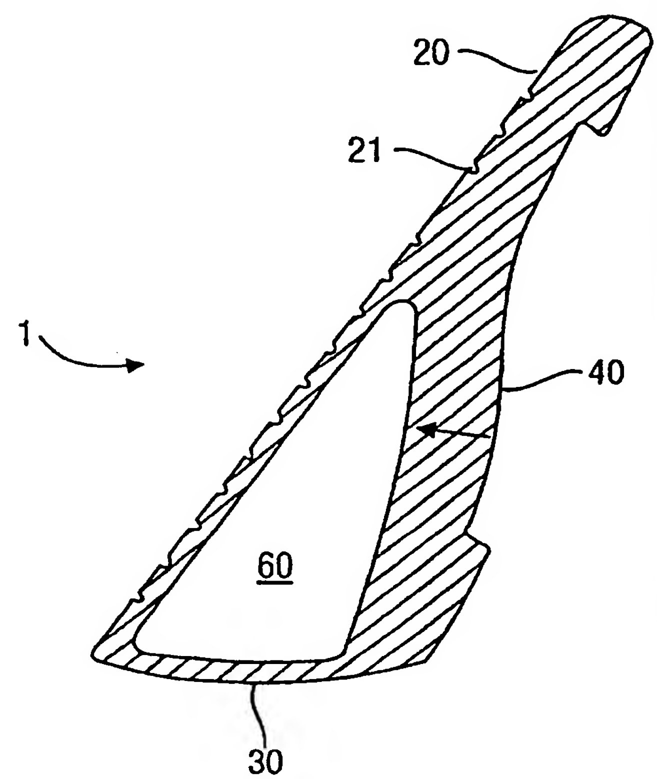
(57) Abstract

This invention is a golf club head (1), comprising a body having a hosel (10), a face (20), a sole, a toe end (30), a heel end (40) and a back, wherein the body encapsulates at least a portion of one or more inserts (60), wherein the body comprises a metal and a ceramic material, and wherein the ceramic material is in the form of grains having size of from about 25 microns to about 150 microns. Processes for the manufacture of a golf club head are also provided.



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DESCRIPTION

GOLF CLUB HEAD

BACKGROUND OF THE INVENTION

This invention relates to a golf club head comprising a body containing a metal and ceramic particles and a core encapsulated in the body.

Experienced golfers recognize that the game of golf is played in the air and not on the ground. To play golf successfully, the player must be able to strike the ball so that it flies high enough so as to carry its maximum distance. At the same time, the shot must be struck such that enough trajectory is achieved to enable the ball to land soft enough to prevent the ball from rolling over the target area, yet still not fly so high as to lose distance. A beginning golfer usually cannot achieve success or enjoyment until the skill of hitting the ball in the air the majority of the time has been mastered. Hence, there has always been a need for a golf club which would enable the beginning golfer to easily get the ball airborne, and enable the experienced golfer to hit the ball high without a loss of distance.

The primary way that trajectory and distance is achieved is through progressively different loft angles that are designed into each of the different club heads in the set of golf clubs. The traditional set of golf clubs is divided into two groups, the woods and the irons. Within the set, the lesser lofted club heads, the #1 wood (heretofore referred to as the driver) in the set of woods and the #1, 2, 3 and 4 irons (heretofore referred to as the long irons) within the set of irons, have the lowest degree of loft within their respective groups. As such, golfers appreciate these clubs as being much harder to hit high enough into the air to achieve their maximum

distance. Even though a tee peg is allowed to elevate the height of the ball when the driver is used, the low degree of loft on the driver makes it hard for all but a small percentage of golfers to use successfully. In the case of the long irons it is also very difficult to master the skill of hitting the ball with such lower lofted heads to achieve the proper trajectory to facilitate a soft landing on the target green.

Within the rest of the clubs in the set which have progressively higher loft angles, less athletically inclined or beginning golfers have a little less difficulty getting the ball airborne, but still occasionally do have trouble hitting the ball to the desired higher trajectory to land the ball softly enough on the green to stop the ball quickly.

The manner in which golf club designers have attempted to produce a golf club head to assist in getting the ball airborne, achieve the desired trajectory and still propel the ball an adequate distance has been to position the club head's mass as low on the club head as possible, to keep the club head's center of gravity as low as possible, and still produce a club head which conforms to the desired weight and accomplish all of this within a size and shape that is cosmetically appealing to golfers. If the center of gravity of the head can be positioned significantly lower than on the other golf club heads of similar loft, size and total mass, the club head would be easier for a golfer to hit into the air and to achieve the optimum trajectory.

In all homogenous designs there is a limit of how low the center of gravity can be positioned. This is because when the requirement of size and shape and total mass is satisfied, the density of the club head material above the center of gravity is the same as the density of the material below the center of gravity and in all other positions on the head. While homogenous metal woodheads and ironheads were designed from the 1970's through the 1990's which had a lower center of gravity than the predecessor club head designs of the 1960's and before, the amount of center of

gravity change was minimal and had a doubtful effect on the actual trajectory and distance achieved by the golfer using the design.

In addition to lowering the center of gravity, club head designers in the 1970's-1990's also began to distribute the available mass of the club head at different points around the head's shape, particularly in ironhead and putterhead designs. Such perimeter weighted designs had the effect of increasing the club head's mass moment of inertia. In golfing terms, this gave the club head the ability to better resist vibration and energy loss due to an impact that occurred off the center of gravity. Since the 1970's numerous ironhead and putterhead designs have been introduced which professed to have a high moment of inertia made possible by variable distribution of the mass of the club head.

Again, just as there was a limit to how low the center of gravity could be engineered on a golf club head with homogenous materials, so too is there a limit to how high the mass moment of inertia can be made by varying the distribution of the available mass of the club head, given the usual weight and shape considerations which must be met.

When low specific gravity fiber composites such as graphite began to be used for making club heads, designers were able to create iron designs with much lower center of gravity location than ever before. Because the graphite had such a low specific gravity, there was a requirement for incorporating a higher density material in the graphite to achieve the required mass for each club head.

In addition, because the graphite/composite material was not strong enough to prevent failure in the form of breaking or fracture in high stress areas, such as the face of the iron where impact occurs and the neck of the iron where the shaft is attached, part of the mass of the high density material had to be devoted to reinforcing the stress prone areas of the head. This meant that a significant portion of the mass which

should have been used for enhancing weight distribution had to be used in less advantageous areas of the head just to keep the heads from failing under the course of normal wear and tear. Designers created a steel piece which comprised the sole, faceplate and neck which was inserted into the club head mold and covered over with the graphite. Designers were able to lower the center of gravity and improve weight distribution (increase moment of inertia) more than what had been possible with homogenous material club heads, but were not able to take full advantage of the mass made available by using the graphite in the construction of the head.

Graphite ironheads were introduced and sold by a number of different golf club manufacturing companies in the 1980's. However, they were never able to achieve a high level of sales success in the golf industry for two very important reasons. First, the graphite possessed very little surface durability and after a very short time in play, the face of the graphite iron began to scratch, chip or delaminate. Second, the graphite club heads were much more expensive than sets made with homogenous material club heads which severely limited the potential market for the lower center of gravity design.

Metal golf club heads, particularly iron heads, have been used for many years. Even today, many golf clubs are cast or forged from metals such as iron or stainless steel. While golf club heads composed of metal alone are known and commonly used, improvements to such clubs are highly sought. Some efforts have focused on the particular metal used to form the club head, such as use of aluminum or aluminum alloy.

For instance, in U.S. Patent 3,250,536, issued in 1966, there is disclosed a golf club head in the shape of an iron, particularly for use as a sand wedge. The club is composed of an aluminum head and a high density metal insert. The patent discloses that the insert provides a low center of gravity. Perhaps the most significant

disadvantage of this golf club head design is that aluminum, which is known to be a soft metal, does not adequately withstand repeated use during use. Furthermore, the center of gravity of this patent's sand wedge is undesirably high.

Golf club heads have also been proposed which make use of a club face made up of ceramic whiskers with metal infiltrated therein, such as shown in Derwent abstract 88-260759/37 of JP-021733 (1988) and Derwent abstract 89-141144/19 of JP-240696 (1989). While the striking surface of such clubs have improved durability, ceramic whiskers are both expensive and carcinogenic, which leads to costly and difficult manufacturing processes to prepare such clubs. Moreover, the present inventor is aware that whiskers do not become adequately wetted by aluminum. Furthermore, whiskers have unidirectional mechanical properties which, in the case of a club head, generate limited resistance to vibration, amplitude waves and wear.

In addition, U.S. Patent 5,037,102 discloses a club head employing a body containing aluminum reinforced with ceramic powder. In this patent it is asserted that such club heads have high strength and hardness. The club head disclosed in this patent is totally made of such ceramic powder reinforced aluminum and is silent as to an insert. The present inventor is aware that the club head disclosed in U.S. Patent 5,037,102 has an undesirably high center of gravity which deleteriously effects the performance of such clubs in use. In addition, the present inventor is aware that the clubs disclosed in this patent are costly to manufacture.

Despite several decades of development, there continues to be great interest in developing new and improved golf clubs. Thus, the stage has been set to create a golf club head design which could achieve or improve on the center of gravity location of the graphite club heads, which could enable the designer to go further into varying the weight distribution of a club head to a much greater extent than any other club head,

and to create such a design which still would possess a durability greater than or at least equal to the homogenous metal club heads.

SUMMARY OF THE INVENTION

The present invention provides a novel golf club which includes significant advantages over prior aluminum head golf clubs.

In one broad respect, the present invention is a golf club head, comprising a body having a hosel, a face, a sole, a toe end, a heel end, and a back, wherein the body encapsulates at least a portion of one or more insert, wherein the body comprises a metal and a ceramic material, and wherein the ceramic material is in the form of grains having a size of from about 25 to about 150 microns.

In another broad aspect, the present invention is a process for the manufacture of a golf club head comprising a body having a hosel, a face, a sole, a toe end, a heel end, and a back and wherein the body at least partially encapsulates one or more insert, wherein the body comprises a metal and a ceramic material, wherein the ceramic material is in the form of grains having a size of from about 25 to about 150 microns, comprising the steps of:

(A) heating a mixture of the metal and the ceramic material into a flowable mass;

(B) casting the flowable mass into a golf club head mold that contains one or more insert secured in the mold such that the flowable mass surrounds the one or more insert;

(C) allowing the flowable mass to cool and harden in the mold to thereby form the body and to thereby form the club head; and

(D) removing the golf club head from the mold.

In yet another broad aspect, the present invention is a process for the manufacture of a golf club head comprising a body having a hosel, a face, a solc, a toe end, a heel end, and a back and wherein the body at least partially encapsulates one or more insert, where the body comprises a metal and a ceramic material, wherein the ceramic material is in the form of grains having a size of from about 25 to about 150 microns, comprising the steps of:

(A) heating a mixture of the metal and the ceramic material into a flowable mass;

(B) casting the flowable mass into a golf club head mold that contains one or more cavities for receiving an insert;

(C) allowing the flowable mass to cool and harden in the mold to thereby form the body and to thereby form the clubhead;

(D) removing the golf head club from the mold; and

(E) attaching said insert to said cavity.

Important aspects of the golf club head of the present invention include use of a metal body comprised of aluminum or aluminum alloy with ceramic particles, not whiskers, dispersed therein. Advantageously, such particles, which generally have a size of from about 25 to about 150 microns, preferably from about 50 to about 70 microns, provide improved combination with aluminum or aluminum alloy relative to whiskers. For example, the grains are more readily wetted as compared to whiskers. Also, golf club heads of the present invention exhibit improved resistance to vibration, amplitude waves and wear. Another important aspect of this invention is a metal insert of high density which may be encapsulated within the body. Another

important advantage of this invention is that the golf club heads may be manufactured with variable weight distribution, depending on the size, shape and location of the metal insert in the body. Likewise, the process of this invention provides a golf club head having these advantages.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 shows a front view of a golf club in the shape of an iron golf club of this invention.

FIG. 2 shows an overhead view of a golf club in the shape of an iron golf club of this invention.

FIG. 3 shows a side view of an iron golf club head of this invention.

FIG. 4 shows another side view of an iron golf club head of this invention.

FIG. 5 shows a rear perspective view of an iron golf club head of this invention.

FIG. 6 shows a cross-sectional view of an iron golf club head of this invention.

FIG. 7 shows a underneath view of a golf club in the shape of a wood golf club of this invention.

FIG. 8 shows an overhead view of a golf club in the shape of a wood golf club of this invention.

FIG. 9 shows a side view of a golf club in the shape of a wood golf club of this invention.

FIG. 10 shows a front view of a golf club in the shape of a wood golf club of this invention.

DETAILED DESCRIPTION OF THE INVENTION

The golf club head of this invention, as described above, comprises a core (insert) within an outer body. The body is composed of metal or metal alloy containing ceramic particles in the shape of grains, not whiskers. Advantageously, the cost of grains is substantially less than the cost of whiskers. More advantageously, a golf head of this invention which utilizes grains has improved mixing of the ceramic particles relative to whiskers and, furthermore, it is believed that the moment of inertia of a golf club of this invention is superior to that of a club made using composite of ceramic whiskers. The ceramic particles generally have an average diameter in the range from about 25 to about 150 microns. Preferably, the average diameter of the ceramic particles is less than about 70 microns. Preferably, the average diameter of the ceramic particles is greater than about 50 microns. Representative examples of ceramic materials used in the composite include silicon carbide, boron carbide and silicon nitride. Generally, at least about 95% of the ceramic material is in the form of grains; preferably at least about 98%; more preferably at least about 99% and most preferably about 100% of the ceramic material is in the form of grains. Preferably, in a golf club head of this invention, the ceramic material is in a form other than whiskers or fibers.

The metal of the body may be aluminum, aluminum alloy, or combination thereof. Preferably, the metal of the body is aluminum or aluminum alloy. The body of the club head, generally, has a density of greater than about 2.5 g/cc. Generally, the body has a density less than about 3 g/cc, preferably less than about 2.8 g/cc.

In one embodiment, the body is composed of metal and ceramic material in such proportions that the density of the body is greater than the density of the metal alone. For example, aluminum has a density of 2.69 g/cc and in one embodiment of

the invention of the body has a density greater than 2.69, more typically greater than about 2.85 g/cc. In this embodiment, the body can be referred to as a composite material.

In another preferred embodiment of this invention, the metal is aluminum, and the body has a density less than that of aluminum. In this aspect of the invention, the body, which can be referred to as a cermet, has a density in the range from about 2.5 to about 2.6 g/cc, and more typically in the range from about 2.5 to about 2.55 g/cc. In this preferred aspect of the invention, the body is in the form of a cermet. In this embodiment, the ceramic materials may be concentrated at the exterior surfaces of the body, with the internal portions of the body having a lower concentration of ceramic particles. This may be achieved through a process of particle centrifugal acceleration which enables the ceramic particles to locate in the desired concentration in the desired positions within the body of the club head. Such a process is available from Nerus Composites Inc. In this regard, the ceramic materials tend to segregate to the outer surface during manufacture of the golf club head. Advantageously, such cermet materials are even less brittle than composites of this invention.

In one embodiment of the present invention, the body is present in the golf club head in an amount of from about 20 to about 30 percent by weight based on the total weight of the head. Materials useful in the practice of this invention to form the body are available from Nerus Composites Inc. of Montreal, Quebec, Canada, which refers to such materials as Metal Matrix Composites ("MMC") which refers to such materials as Metal Matrix Composites when the concentration of ceramic particles are concentrated throughout the aluminum alloy matrix, and cermet when the particles are concentrated at a specific location in the matrix forming a distinct metallographic sandwich of two different materials within the same structure. In addition, cermets as described above are available from Nerus Composites Inc. Nerus 45 and Nerus 55 are

two such MMC's, available from Nerus Composite Inc., which can be used in the practice of this invention. Nerus 45 and Nerus 55 are examples of MMC's which can be turned into cermet as described by the manufacturing process. It is possible to create a wide variety of bodies, in either composite or cermet form, which exhibit a specific gravity one third that of stainless steel, a strength that is over 50% greater than stainless steel and vibration resistance that is two and one half times greater than stainless steel. In addition, the surface durability of the body of this invention is greater than graphite and even greater than that of stainless steel so that the clubs of this invention will not show wear or will not fail from wear and tear beyond the range of normal use.

The insert of the club head has a density at least as great as that of iron, i.e., greater than or equal to about 7.87 g/cc at 20°C. The core or insert is typically made of a metal or metal alloy. Representative examples of materials that can be used to make the core include brass, copper, iron and steel. The shape of the core can be of a variety of shapes, as one of skill in the art may appreciate. While generally the core may comprise a single piece spanning a transverse portion of the body, it is within the scope of this invention that the core may comprise two or more distinct pieces such as two pieces on opposite sides of the sweet spot of the club face. The size, shape and position of the insert in the golf club head may vary depending on the type of club head, loft of the club head, and general design of the club head, as may be appreciated to one of skill in the art.

The body of the golf head may cover only a portion of the insert. In one embodiment of this invention, the body encapsulates (surrounds) at least a portion of the core. In another embodiment of this invention, the body totally encapsulates the metal core. In one embodiment of the present invention, the metal core is present in

the golf club head in an amount of from about 70 to about 80 percent by weight based on the total weight of the golf club head.

In a golf club head of invention, the body has a tensile strength of greater than about 350 MPa, preferably from about 379 MPa to about 428 MPa. In a golf club head of this invention, generally, the center of gravity is less than about 5mm lower than a homogenous golf club head of the same blade height, length, and breadth dimensions.

Generally, a golf club head of this invention is composed of a hosel, a face, a body and a sole with an insert disposed therein. Advantageously, the insert is permanently secured within the body without the need for secondary means of support such as glue (epoxy) or screws. While not wishing to be bound by theory, it is believed that the molten aluminum in the body forms both a physical and chemical bond with the insert when the melting point of the insert is less than that of aluminum. The hosel, or neck, is in the form of a cylindrical cavity adapted for receipt of a golf club shaft, i.e., the hosel defines a bore for receiving the club shaft. Typically, such hosel is placed on a given end of the head, as is well known to one of skill in the art. The face forms the striking surface for contact with the golf ball. Generally, the face contains grooves of depth, width, and shape that are well known to one of skill in the art. The back of the club can be in a form containing perimeter weighting or in a form of a blade, as would be well known to one of skill in the art. The sole of the golf club is the bottom surface of the club which may face the ground during use of the club.

In another embodiment, the clubhead is formed from the molten material such that a cavity is created. In a subsequent step, the cavity receives the insert which is affixed by use of press fitting, adhesion or conventional fasteners. In this embodiment, the insert may be partially encapsulated by the club head, but not completely encapsulated as may be achieved with the embodiment discussed above.

In one embodiment of this invention, the golf club head is in the form of a woodhead. In another embodiment of this invention, the golf club head is in the form of an ironhead. In still another embodiment of this invention, the golf club head is in the form of a putter.

Generally, a golf club head of this invention is prepared by securing a metal insert inside a mold and casting the body over and around the metal insert. More particularly, the golf club head of this invention is prepared by heating the body to a temperature such that the metal is molten to thereby form a flowable body and filling a mold that defines a golf club head shape. The technique used to manufacture the golf club head is commonly referred to as casting. The core (insert, typically a metal or metal alloy) is positioned and secured in the mold. During the fill step, the metal core is affixed such that it does not move during the filling step, as by attaching the metal core to a jig within the mold. The filling can be accomplished by pouring or injecting a molten mixture of metal and ceramic particles in a mold while maintaining a vacuum in the mold. Generally the mixture becomes flowable at temperatures in the range from about 675°C to about 725°C. During the casting process, including cooling of the mold after filling, the metal core insert becomes bonded to the inner surface of the mixture in a specific location so as to elicit the desired weight distribution of the club head. The bond between the mixture, which forms the body, and the metal insert is permanent since the insert is encapsulated within the body and held by mechanical lock of the insert shape. In cases of using a lower melting point metal insert, such as zinc or brass, the bonding of the two different materials may be further enhanced by a fusing of the surface of the lower melting point material to the higher melting body made possible by fact that the melting point of the body, particularly aluminum based composites, is slightly greater than the melting point of the brass or zinc insert. The position of the metal core (or insert) can be positioned

appropriately to result in a club head having the desired moment of inertia and center of gravity and weight distribution. The metal insert may or may not be visible at any point on the surface of the body depending on the desire of the designer to allow the insert to be exposed to the surface. In one embodiment of this invention, the metal insert will be visible at the toe and heel areas of the club head after casting.

In another embodiment, the molten material is poured or injected into a form that does not contain an insert. However, the mold is shaped such that a cavity is formed. After the molten materials harden, the insert may be attached to the cavity by various means including press fitting, adhesives (glue, epoxy, etc.) or conventional fasteners (pins, screws) or by heating of the insert or clubhead to produce a surface suitable for bonding with either the cavity or the insert. The insert may be singular or multiple, and multiple inserts may be attached to each other by the same means as described herein for attaching the insert to the cavity.

Another advantage of the body of this invention is that it is strong enough to eliminate the need for high density material reinforcement in the high stress areas of the face and neck. Therefore, all of the possible extra mass made available by the use of the low specific gravity body material for the shape of the head can be used to enhance the weight distribution/moment of inertia.

For example, in a #2 iron prototype of a club head of this invention wherein the insert extended from head to toe of the head, the high density material metal insert (brass - sp.gr. = 8.55 g/cc) occupied an estimated 35% of the volume of the head but accounted for 73% of the total mass of the head, while the composite which formed the outer surface of the head, the entire neck, the entire top half of the head and the entire surface area of the head, occupied an estimated 65% of the volume of the head but accounted for only 27% of the total mass of the head. In another #2 iron prototype

wherein the body is composed of cermet, the insert accounted for about 80% of the total mass of the head.

It is contemplated that other versions of the variable weight distribution, bi-material, ironhead include a wide variety of designs which can be bigger in total volume to satisfy the popularity of oversize club heads but yet still have a center of gravity and weight distribution which is far more beneficial to shotmaking than any other iron of the same volume and size. It is further contemplated that the club heads may have the heavy material inserts located strictly in the toe and heel areas only and not behind the center area of the face, which will optimize the perimeter weighting/higher moment of inertia of the heads much greater than any homogenous material or even bi-material graphite/steel design.

Among woods, the variety of weight distribution to club head size variations is also virtually limitless. Using bodies with heavy density material inserts, the woodhead can be made oversize but still possess a low center of gravity, can be made with the center of gravity closer to the face or closer to the back to change the flight trajectory of the shot for any given loft, or in the preferred embodiment of the wood, can be centered all around the head and positioned within of the bottom 20% of the volume of an ironhead and within 30% of the volume of the woodhead, which thereby keeps the center of gravity very low and increases the moment of inertia at the same time.

In the case of putter design, the heavy material insert can be totally encapsulated with the body, thus creating a form of achieving a superior weight distribution.

In FIG. 1 there is shown a golf club of the present invention in the form of an iron. In FIG. 1, the golf club includes hosel 10 which connects to a body 1 of the golf club. The body contains metal and a ceramic material as described above which

forms the striking surface or face 20 and bottom surface or sole 30. The striking surface 20 includes recessed grooves 21 on the surface of face 20. A brass insert not shown extends longitudinally through body 1 extending through the body from the heel 40 (hosel side of the club head) to the toe 30 (end of club opposite the hosel).

FIG. 2 depicts the golf head of FIG. 1 viewed from above. The hosel 10 connects to body 1. The body contains metal and a ceramic material and includes striking surface 20. Striking surface 20 contains recessed grooves, which can be in the shape of a U or V. Hosel 10 is adapted for receiving a shaft which is secured in hosel 10 by an adhesive such as an epoxy adhesive. The shaft, not shown, may be any shaft used to make a golf club. Representative examples of such shafts include hollow stainless steel tubes and hollow graphite or composite tubes. Selection of a shaft is not critical to the present invention.

In FIG. 3 there is shown a side view of one golf club head of present invention. The golf club head depicted in FIG. 3 includes a hosel 10 connected to a body 1. The body 1 includes a striking surface 20, a rear surface 40 and a bottom surface or sole 30. The body 1 encapsulates brass insert 60. Brass insert 60 runs perpendicular to this view through body 1. The size, shape and density of insert 60 may be varied depending on the desired characteristics of the final golf club.

In FIG. 4, there is shown the golf club head of FIG. 3 from the opposite view. Again, hosel 10 connects to body 1. The body 1 includes striking surface 20, rear surface 40 and sole 30. In this embodiment of the invention, the golf club head includes a recessed cavity 50. It may be observed that the golf club head of FIG. 4 includes perimeter weighting around the back face of the club head. Also shown in FIG. 4 is insert 60. The body 1 partially encapsulates insert 60, with insert 60 being exposed on the hosel end of the golf club head.

In FIG. 5, there is depicted a golf club head of the present invention. The golf club head includes body 1 which is connected to hosel 10. An insert 60 runs longitudinally through the golf club head. A bottom surface or sole 30 is shown as well as a recessed cavity 50 formed from the body 10.

In FIG. 6, there is shown a cross-sectional view of a golf club head of the present invention. The cross-sectional view of a body 1 includes a striking surface 20 which contains recessed grooves 21. The body 1 also includes a sole 30 and a rear surface 40. The body 1 in this view encapsulates insert 60; that is to say, the body surrounds insert 60, but only partially surrounds insert 60.

In FIGS. 7-10 there are shown underneath, overhead, side, and front views of a wood golf club head of this invention. The body 101 contains metal and a ceramic material as described above which forms the striking surface or face 120 and sole 160. The golf club includes hosel 110 which connects to a body 101 of the golf club. In FIG. 8 the sole 160 is also depicted by dotted lines. The striking surface 120 may include recessed grooves, not shown. A brass insert 150 depicted by dotted lines extends longitudinally through body 101 extending from the heel 140 (hosel side of the club head) to the toe 130 (end of club opposite the hosel), and extends to the back 170 of the head. The insert 150 may be surrounded above and below by the metal/ceramic material. In this embodiment the insert 150 has three portions 151 which are flush with the exterior of body 101. In FIG. 10, a golf club shaft 180 has been inserted into hosel 110. A club head of FIGS. 7-10 may be made by conventional one piece casting with the insert placed within the mold prior to casting, and with the core of the mold being dissolvable for removal after casting, as is well known to one of skill in the art.

During use, the golf club head depicted in FIGS. 1-6 may strike a golf ball on striking surface 20. The insert 60 serves to lower the center of gravity of the golf club

head. Further, due to the weight distribution within the golf club head due to the unique combination of the materials used to form body 1 and the high density material used to form insert 60, the moment of inertia of the golf head of the present invention are both increased.

It may be appreciated that the golf club heads depicted in FIGS. 1-10 admit to other shapes and constructions. For example, the golf club head shown is in the form of an iron and a wood, but may also include a putter. Similarly, the golf club head may be in the form of a bladed iron, as opposed to the cavity back, perimeter weighted golf club irons depicted in FIGS. 1-6.

CLAIMS:

1. A golf club head, comprising a body having a hosel, a face, a sole, a toe end, a heel end, and a back, wherein the body encapsulates at least a portion of one or more insert, wherein the body comprises a metal and a ceramic material, and wherein the ceramic material is in the form of grains having a size of from about 25 to about 150 microns.

2. The golf club head of claim 1, wherein the one or more insert has a density at least that of iron.

3. The golf club head of claim 1, wherein the metal is aluminum alloy.

4. The golf club head of claim 1, wherein the body has a density of from about 2.5 to about 3 g/cc.

5. The golf club head of claim 1, wherein the body is in the form of a cermet, having a density in the range from about 2.5 to about 2.6 g/cc, and wherein the metal is aluminum.

6. The golf club head of claim 1, wherein the ceramic material is silicon carbide, boron carbide, or silicon nitride.

7. The golf club head of claim 1, wherein at least about 95% of the ceramic material is in the form of grains.

8. The golf club head of claim 1, wherein the ceramic material is in a form other than whiskers or fibers.

9. The golf club head of claim 1, wherein the one or more insert is present in an amount of from about 70 to about 80 percent by weight based on the total weight of the golf club head.

10. The golf club head of claim 1 wherein the ceramic particles are in the form of angular grains having an average diameter in the range from about 50 to about 70 microns.

11. The golf club head of claim 1, wherein one insert is in the form of a single piece is employed.

12. The golf club head of claim 1, wherein the one or more insert is positioned from the heel end to the toe end of the club head.

13. A process for the manufacture of a golf club head comprising a body having a hosel, a face, a sole, a toe end, a heel end, and a back and wherein the body at least partially encapsulates one or more insert, wherein the body comprises a metal and a ceramic material, wherein the ceramic material is in the form of grains having a size of from about 25 to about 150 microns, comprising the steps of:

a) heating a mixture of the metal and the ceramic material into a flowable mass;

b) casting the flowable mass into a golf club head mold that contains one or more insert secured in the mold such that the flowable mass surrounds the one or more insert;

c) allowing the flowable mass to cool and harden in the mold to thereby form the body and to thereby form the club head; and

d) removing the golf club head from the mold.

14. The process of claim 13, wherein the insert has a density at least that of iron; wherein the metal is aluminum, and wherein the ceramic material is silicon carbide, boron carbide, or silicon nitride.

15. The process of claim 13, wherein the body has a density of from about 2.5 to about 3 g/cc.

16. The process of claim 13, wherein one or more insert is present in an amount of from about 70 to about 80 percent by weight based on the total weight of the golf club head.

17. The process of claim 13, wherein the ceramic particles are in the form of angular grains having an average diameter in the range from about 50 to about 70 microns.

18. The process of claim 13, wherein one insert in the form of a single piece is employed.

19. A process for the manufacture of a golf club head comprising a body having a hosel, a face, a sole, a toe end, a heel end, and a back and wherein the body at least partially encapsulates one or more insert, where the body comprises a metal and a ceramic material, wherein the ceramic material is in the form of grains having a size of from about 25 to about 150 microns, comprising the steps of:

a) heating a mixture of the metal and the ceramic material into a flowable mass;

b) casting the flowable mass into a golf club head mold that contains one or more cavities for receiving an insert;

c) allowing the flowable mass to cool and harden in the mold to thereby form the body and to thereby form the clubhead;

d) removing the golf head club from the mold; and

e) attaching said insert to said cavity.

20. The process of claim 19, wherein said insert is attached to said cavity by a means selected from the group consisting of press fitting, adhesion or use of a fastening device.

1/6

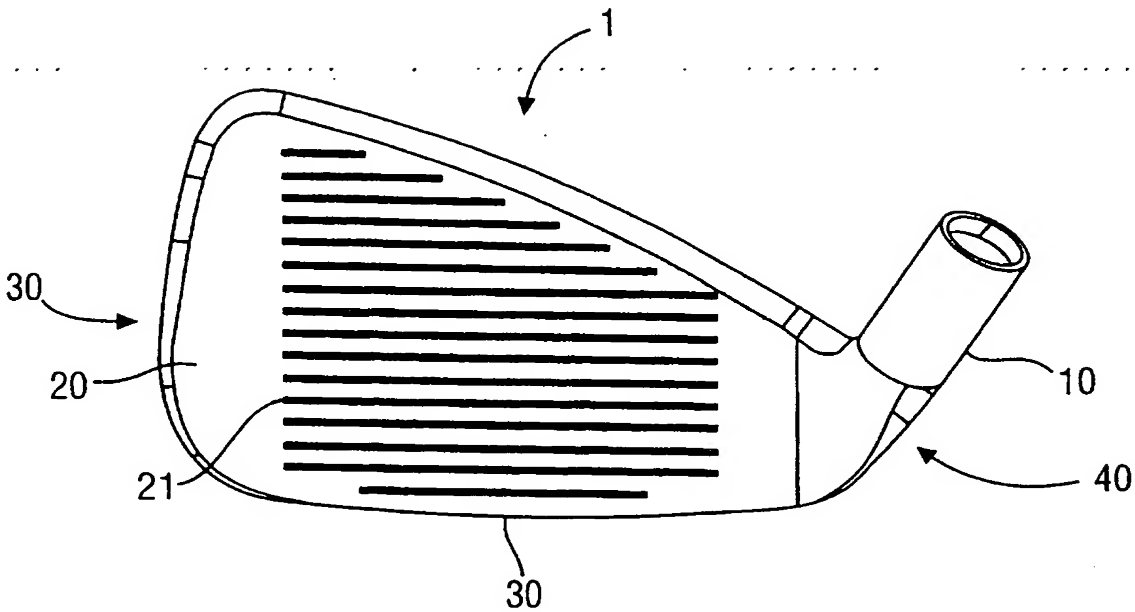

FIG. 1

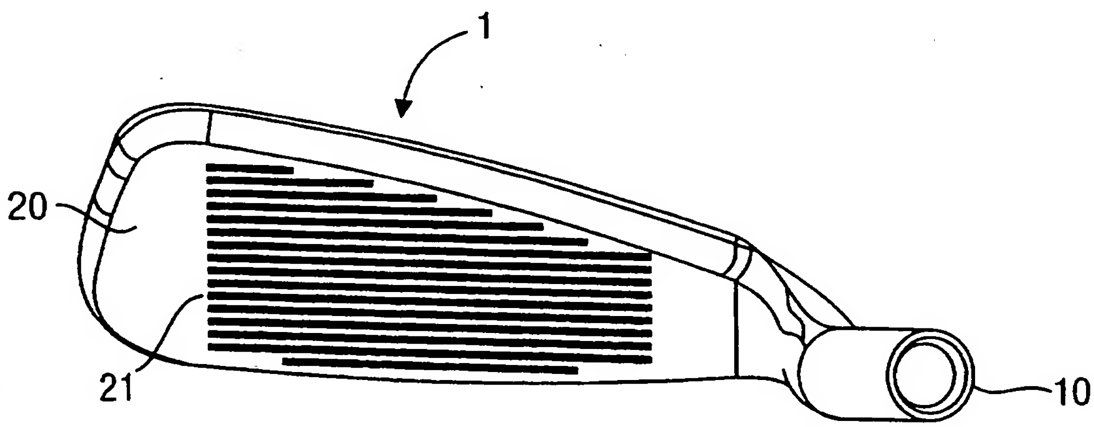

FIG. 2

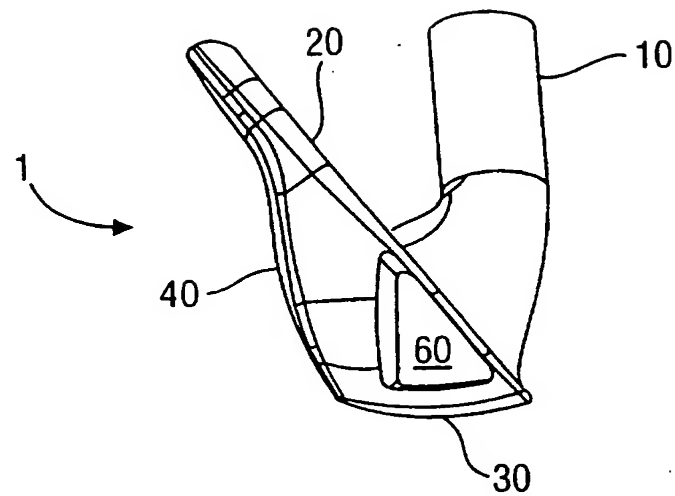

FIG. 3

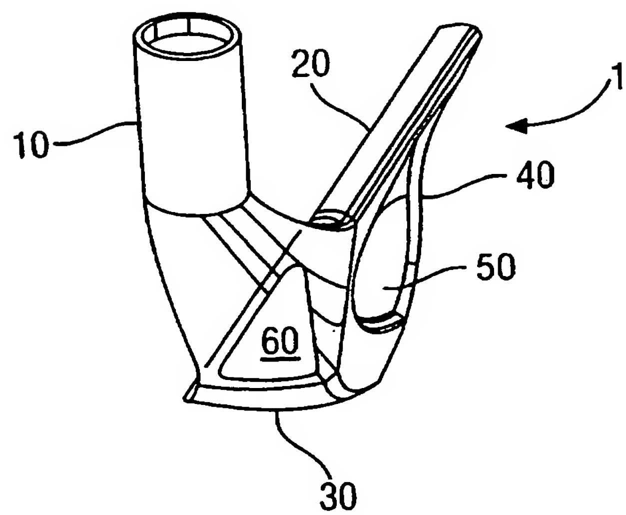

FIG. 4

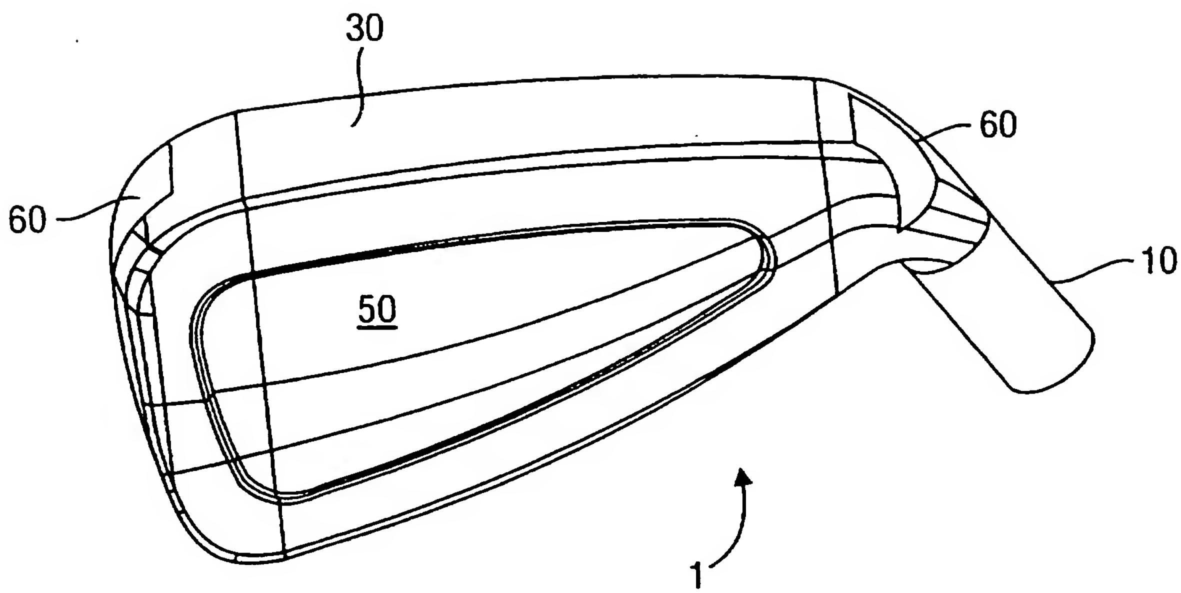

FIG. 5

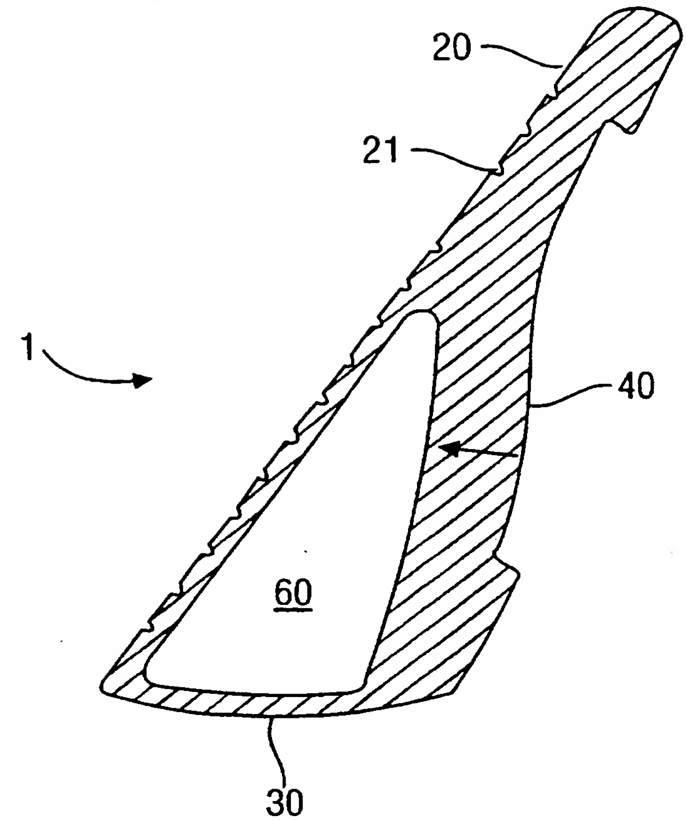

FIG. 6

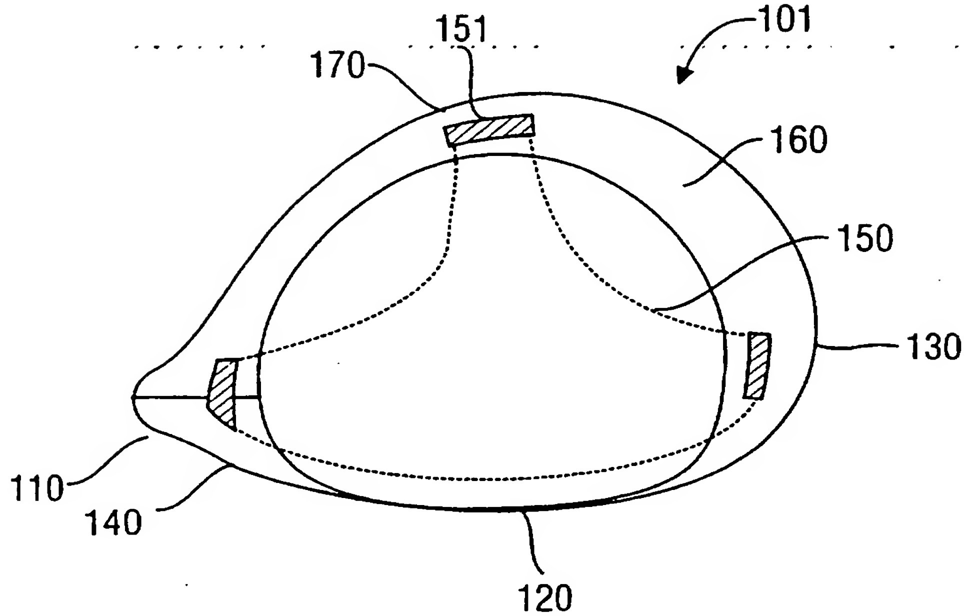
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FIG. 7

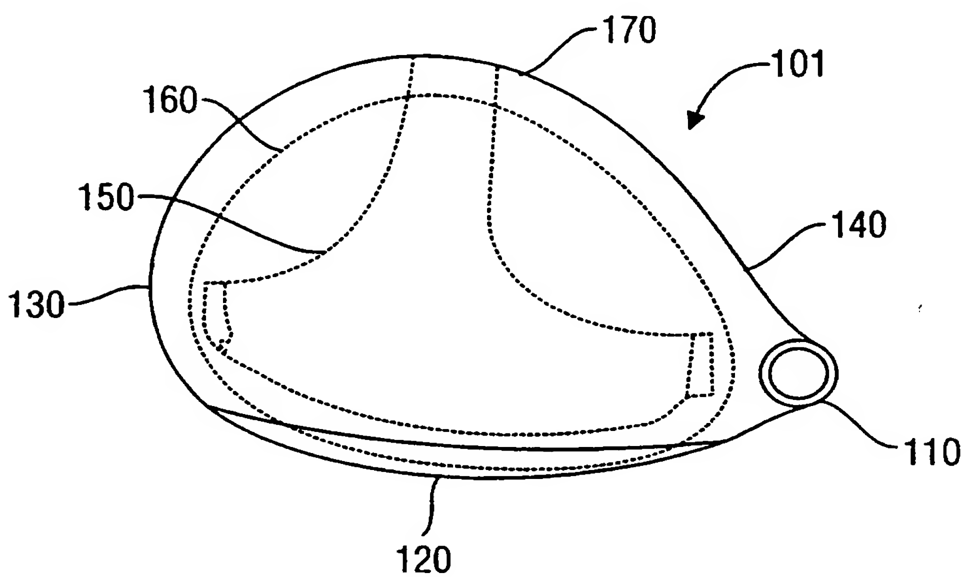
170
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FIG. 8

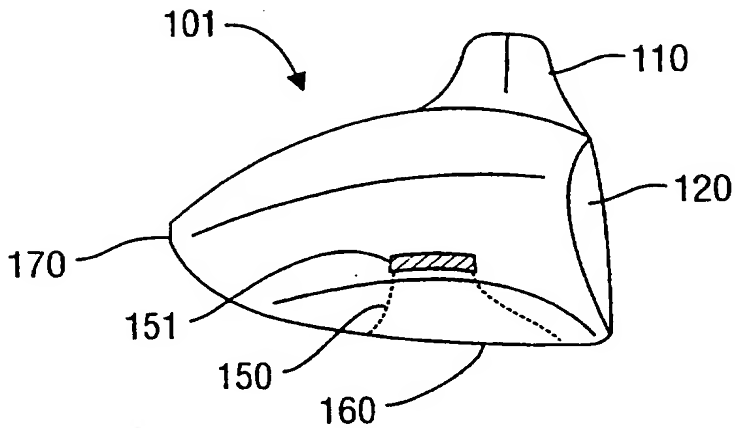

FIG. 9

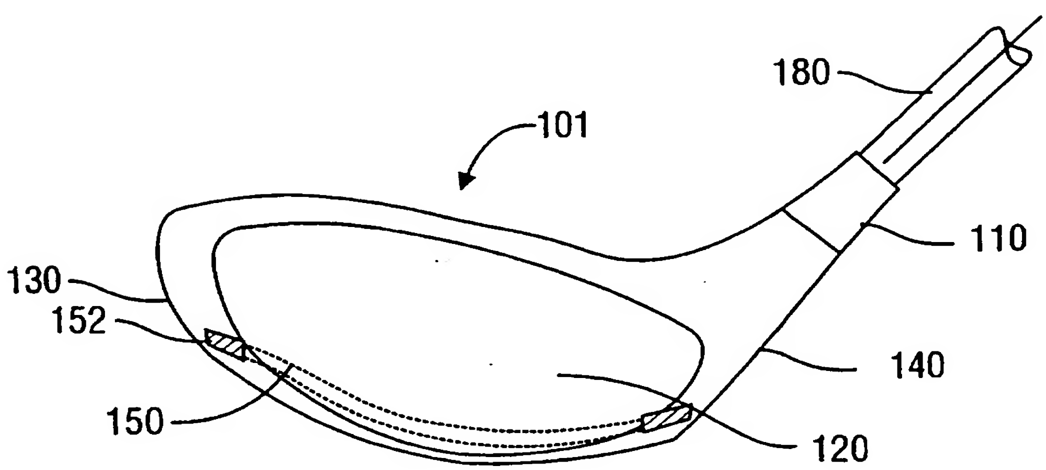

FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US97/00962

A. CLASSIFICATION OF SUBJECT MATTER

IPC(6) :A63B 53/04
US CL :473/348, 349
According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 75/229; 473/348, 349

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

APS

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X --- Y	US 4,687,205 A (TOMINAGA et al) 18 August 1997, Figs. 1 and 2; col. 2, lines 9-25; col. 3, lines 23-26, 45 and 52; and col. 4, lines 47-57.	19, 20 --- 1-12, 14
Y	US 5,143,540 A (PYZIK et al) 01 September 1992, col. 1, lines 18-21; col. 4, lines 20-27, col. 19, line 24; and col. 20, line 1.	1-18
Y	US 4,793,616 A (FERNANDEZ) 27 December 1988, Figs. 1 and 2; Abstract; col. 2, lines 3-6; and col. 6, lines 51-53.	9, 11, 13-18

☐ Further documents are listed in the continuation of Box C. ☐ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

28 APRIL 1997

Date of mailing of the international search report

19 MAY 1997

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